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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
08/801,812	02/14/1997	JOHN H. GIVENS	11675.106	6774

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EXAMINER

MALDONADO, JULIO J

ART UNIT PAPER NUMBER

2823

DATE MAILED: 04/11/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

08/801,812

Applicant(s)

GIVENS, JOHN H.

Examiner

Julio J. Maldonado

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 January 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-28 and 36-63 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-28 and 36-63 is/are rejected.
- 7) ☒ Claim(s) 5 and 46 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Objections

1. Claims 5 and 46 are objected to because of the following informalities: In claim 5, where the applicant cites a "...diffusion barrier is an..." should cite "...diffusion barrier is an...". In claim 46, where the applicant cite "...and a uniform..." and "...not greater then..." should cite "...and an uniform..." and "...not greater than...". Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claim 11 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In reference to claim 11, the applicant claims "applying energy to said energy absorbing layer utilizes". This claim fail to point out a particularity of the invention.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1-12, 14-28 and 36-63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dixit et al. (U.S. 6,333,265) in view of Xu et al. (U.S. 6,217,721).

In reference to claim 1-5, 7-12, 14, 16-28 and 36-63, Dixit et al. (Fig.6-7) in a related method to improve contacts within vias and trenches teach forming a recess (28) within a dielectric material (26) situated on a semiconductor lower substrate (22, 24), said recess extending below a top surface of said dielectric material (26) and having an aspect ratio greater than about four (4) to one (1); forming a titanium nitride (TiN) diffusion barrier layer (47) on the recess (28) within the dielectric material (26) by a CVD process; forming an aluminum layer (50) within said recess (28), the material from which the diffusion barrier layer (47) is composed having a melting point greater than that of a material from which the aluminum layer (50) is composed; forming an energy absorbing layer (column 8, lines 43-47) on said aluminum layer (50); applying omnidirectionally, energy to said energy absorbing layer (column 8, lines 43-47) to cause said aluminum layer (50) to flow within said recess (28); and removing portions of the energy absorbing layer (column 8, lines 43-47) and the aluminum layer (50) that are situated above the top surface of the dielectric material (26) by an abrasive planarization step (column 2, line 35 – column 8, line 58).

Dixit et al. fail to teach heating the diffusion barrier layer in a nitrogen-containing environment; forming a titanium nitride seed layer on the diffusion barrier layer, the diffusion barrier layer being composed of a material having a melting point greater than or equal to that of a material from which the seed layer is composed; forming the aluminum layer on the seed layer including the portion of the seed layer within the

recess, the material from which the seed layer is composed having a melting point greater than or equal to that of the material from which the aluminum layer is composed; and that the energy absorbing layer having a greater thermal absorption capacity than that of said conductive layer, said energy absorbing layer comprising titanium nitride.

However, Xu et al. (Fig.8) in a related method to form interconnects teaches heating the diffusion barrier layer in a nitrogen-containing environment; the formation of a titanium nitride seed layer (164) prior to the formation of the aluminum layer (156); and forming the aluminum layer (156) on the seed layer (164) including the portion of the seed layer (164) within the recess (152), the material from which the seed layer is composed having a melting point greater than that or equal to that of the material from which the aluminum layer (156) is composed (column 3, line 65 – column 6, line 45). Xu et al., (Fig.16-17) in another embodiment of the invention, teaches forming a titanium nitride layer (338) over the aluminum layer (338) (column 25, lines 21-46).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to heat the barrier layer, include a seed layer and an energy absorbing layer as taught by Xu et al. and incorporate such teaching into the interconnect structure of Dixit et al., since by heating the barrier layer in a nitrogen environment substantially reduces the electronic barrier at the metal-semiconductor interface (column 9, lines 39-45); the addition of titanium nitride as a seed layer improves the flow of aluminum into an interconnect at moderate temperatures (column 6, lines 40-45) and, by incorporating an energy absorbing layer improves the delineation of the aluminum layer into interconnects (column 26, lines 17-19).

In reference to claim 6, Dixit et al. in combination with Xu et al. teach forming the titanium nitride seed layer by a CVD deposition step (Dixit et al., column 7, lines 33-40 and Xu et al., column 25, lines 21-46).

In reference to claims 15 and 22, Dixit et al. teaches that the recess (28) comprises a contact hole situated below a trench (column 2, lines 49-52), said semiconductor substrate (22, 24) assembly having a lower substrate defining a plane, said contact hole terminating at an end thereof at said lower substrate and terminating at an opposite end thereof at said trench, said trench extending from said opposite end of said contact hole to a top surface of said dielectric material, the trench extending parallel to the plane of the lower substrate (column 2, line 35 – column 8, line 58).

6. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dixit et al. ('265) in view of Xu et al. ('721) as applied to claims 1-12 and 14-15 above, and further in view of Taguchi (U.S. 6,306,761).

In reference to claim 13, Dixit et al. in view of Xu et al. teach all aspects of the invention but fail to teach removing the portions of the energy absorbing layer and the aluminum layer by a chemical mechanical polish. However, Taguchi (Fig.8-10) in a related method to form interconnects teaches using chemical-mechanical polishing process to remove portions of materials overlaying the interconnect (column 1, line 20 – column 10, line 9). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate the chemical-mechanical process of Taguchi in the method of Dixit et al. and Xu et al., since CMP process

ensures the resolution of lithography and the reliability of an upper interconnection (column 1, lines 20-26).

Conclusion

7. Papers related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in Crystal Plaza 4, room 3C23. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is **(703) 305-3432**. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Julio J. Maldonado** at **(703) 306-0098** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by e-mail via julio.maldonado@uspto.gov. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy, can be reached on (703) 308-4918.

Any inquiry of a general nature or relating to the status of this application should be directed to the **Group 2800 Receptionist** at **(703) 308-0956**.


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PRIMARY EXAMINER

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